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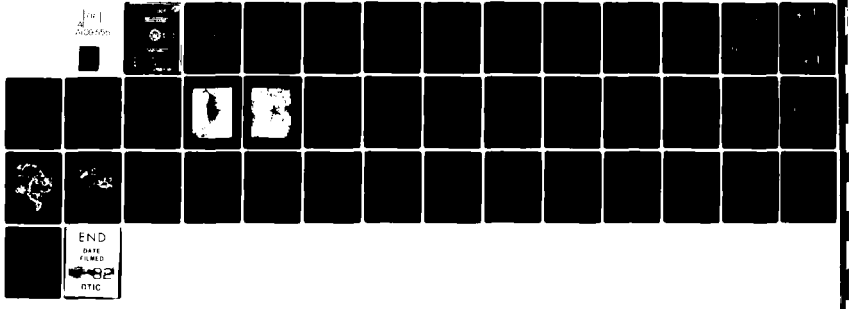

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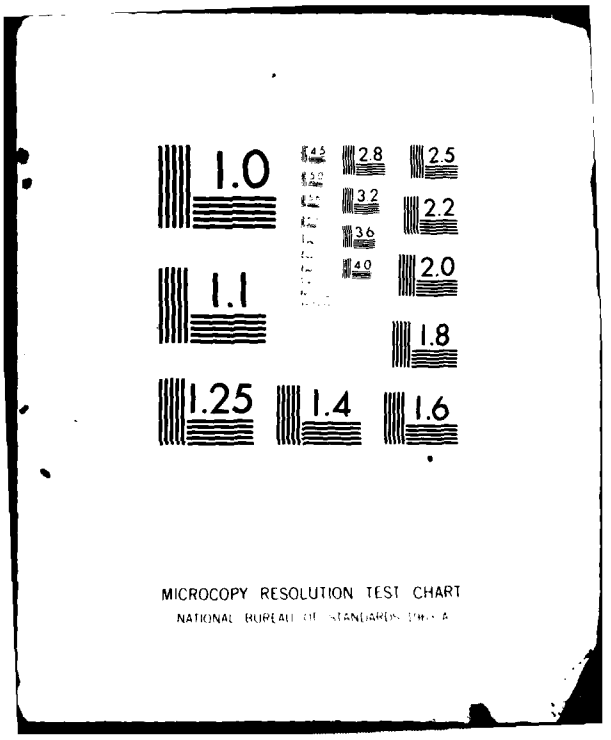
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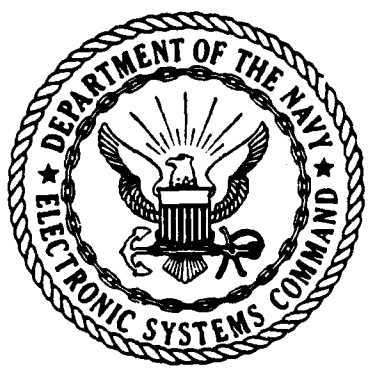

SYSTEM AND SITE DEFINITION, PROGRAM PLANS

ENVIRONMENTAL SUMMARY

AND SUPPLEMENTAL INFORMATION

DECEMBER 1981

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U.S. Navy communications with submarines will be improved by deploying a small, operational Extremely Low Frequency (ELF) communications system. This system will be attained by upgrading the existing ELF Communications Facility near Clam Lake, Wisconsin and building a second ELF Communications facility in the Upper Peninsula of Michigan. The two facilities will be operated synchronously when completed and will transmit coded messages to ELF receiving systems installed on all submarines. This report identifies the work to be done to implement the ELF communications plan approved by the President.

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FOREWORD

President Reagan notified the Congress on October 8, 1981 of his decision to improve U.S. Navy communications with submarines by deploying a small, operational Extremely Low Frequency (ELF) communication system. This system will be attained by upgrading the existing ELF Communications Facility near Clam Lake, Wisconsin and building a second ELF Communications Facility in the Upper Peninsula of Michigan. The two facilities will be operated synchronously when completed and will transmit coded messages to ELF receiving systems installed on all submarines.

Coded ELF signals can be received by submarines at great depths and high speeds. Submarines can be notified to approach the surface at designated times to receive instructions from other transmitting sources. The improved ELF system will reduce the risk of detection by allowing submarines to remain deep for long periods of time, will enhance survivability by limiting the time required near the surface to search for and receive new instructions, and will improve strategic flexibility through command control communications from shore commanders to submarines patrolling or transiting at widely varying depths and speeds.

This report identifies the work to be done to implement the ELF communications plan approved by the President. Planned improvements of the Wisconsin Facility and the communications system to be built in Michigan are described, and supplemental information is provided about environmental protection, initially described in environmental impact statements in 1977. Environmental statements, supplements and associated reports previously issued are listed on pages A-1 and A-2 with information about their availability and cost.

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INTRODUCTION

THE PRESIDENT'S DECISION

President Reagan advised the Congress on October 8, 1981 that he has decided to proceed with the deployment of an ELF (Extremely Low Frequency) Communications System. The President's decision includes the following:

- Upgrade the existing ELF facility in Wisconsin;
- Build a new ELF transmitter and a 56-mile antenna system in Michigan;
- Build ELF receivers for submarines;
- Achieve an initial operating capability in Fiscal Year 1985.

EVOLUTION OF ELF COMMUNICATIONS

Extremely low frequency communications takes advantage of the fact that electromagnetic energy of long wavelengths propagates for very long distances in the space between the earth's surface and the ionosphere with little loss of signal strength. Unlike energy at higher frequencies (shorter wavelengths), ELF signals also penetrate sea water with little loss of strength. These features permit communications with submarines at long distances from a land-based ELF transmitter without the need for intermediate radio relay stations or the need for submarines to rise near the surface of the seas to receive messages.

The Department of the Navy constructed an experimental ELF transmitter and antenna near Mount Airy in North Carolina in the early 1960's and demonstrated that ELF signals could be produced at a land base and received by submarines. The transmitting antenna, approximately 109 miles long, and built on utility poles like an electric power distribution line, radiated less than one watt of ELF power.

The experiments in North Carolina, in addition to demonstrating decisively that ELF communications is possible, also identified several factors that are critical to achieving an ELF communications capability at reasonable economic cost and social compatibility. Very low electrical conductivity deep in the

earth is needed for efficient transmitting antenna operations*, and electrical interference between ELF transmitting antennas and public utility systems must be controlled. Low electrical conductivity deep in the earth is characteristic over a relatively large area of the upper Great Lakes region. Low population density and large areas of public forests also are characteristic. These factors make the area most suitable for ELF communications.

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* Kruger, B; SEAFARER Extremely Low Frequency (ELF) Submarine Command and Control Communications System; Naval Electronic Systems Command; June 1975.

THE ROLE OF ELF COMMUNICATIONS

The ELF communications concepts developed in the 1970's could transmit almost any coded message of interest to submarines throughout the oceans of the world. No other asset would be needed to communicate with deep, fast-moving submarines. SANGUINE was a survivable concept (many buried transmitters and antennas) in terms of other nations' attack capabilities in the early 1970's. SEAFARER (several surface transmitters) was not intended to survive a foreign attack. Both systems were very large, and both depended upon very low deep-earth electrical conductivity for efficient operations.

Figures 1 and 2 illustrate communications to submarines. A submarine can receive messages from satellites in space by using a mast antenna. This requires the receiving antenna to clear the surface of the ocean, a position at which the submarine can more easily be detected. As an alternative, a floating wire antenna or a towed buoy antenna can be used to receive Very Low Frequency (VLF) messages from shore transmitters. The submarine must approach the surface, and its speed and maneuverability are restricted by the long trailing wire or the towed buoy. Both the submarine and antenna are more detectable at shallow depths.

An airborne VLF system, called TACAMO, currently provides survivable communications to submarines. It is a part of the Minimum Essential Emergency Communications Network (MEECN). TACAMO aircraft transmit VLF messages from dual trailing wire antennas. Submarines can receive those messages at ranges well over 3000 nautical miles by using either floating wire or towed buoy antennas. Survivability is achieved by the mobility of the aircraft.

The ELF Communications Program approved by the President will improve the ability of submarines to remain undetected, to receive important messages and thereby remain safe and effective as other nations improve their abilities to monitor U.S. submarine operations. Coded messages would be sent continuously to advise submarines to maintain their current operations (speed, course and destination), to change their operations (change destination, for example), or to receive transmissions by another means. The ELF signals can be received at great depths and high speeds. A submarine may approach the surface at an opportune time and use its other antennas to receive instructions from another transmitting source, such as a TACAMO aircraft. Thus, the ELF system

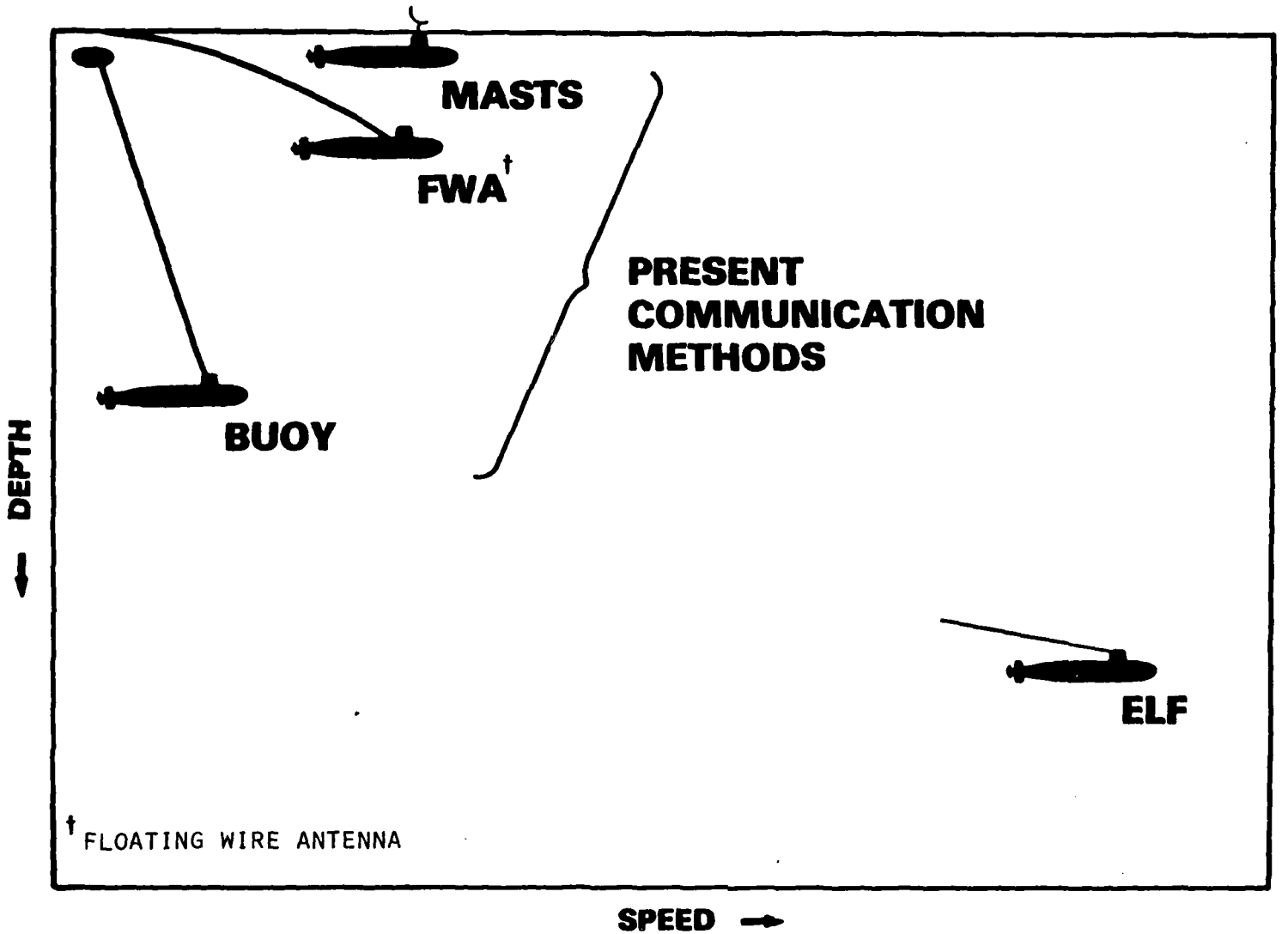


FIGURE 1 - SUBMARINE COMMUNICATIONS RECEIVING METHODS

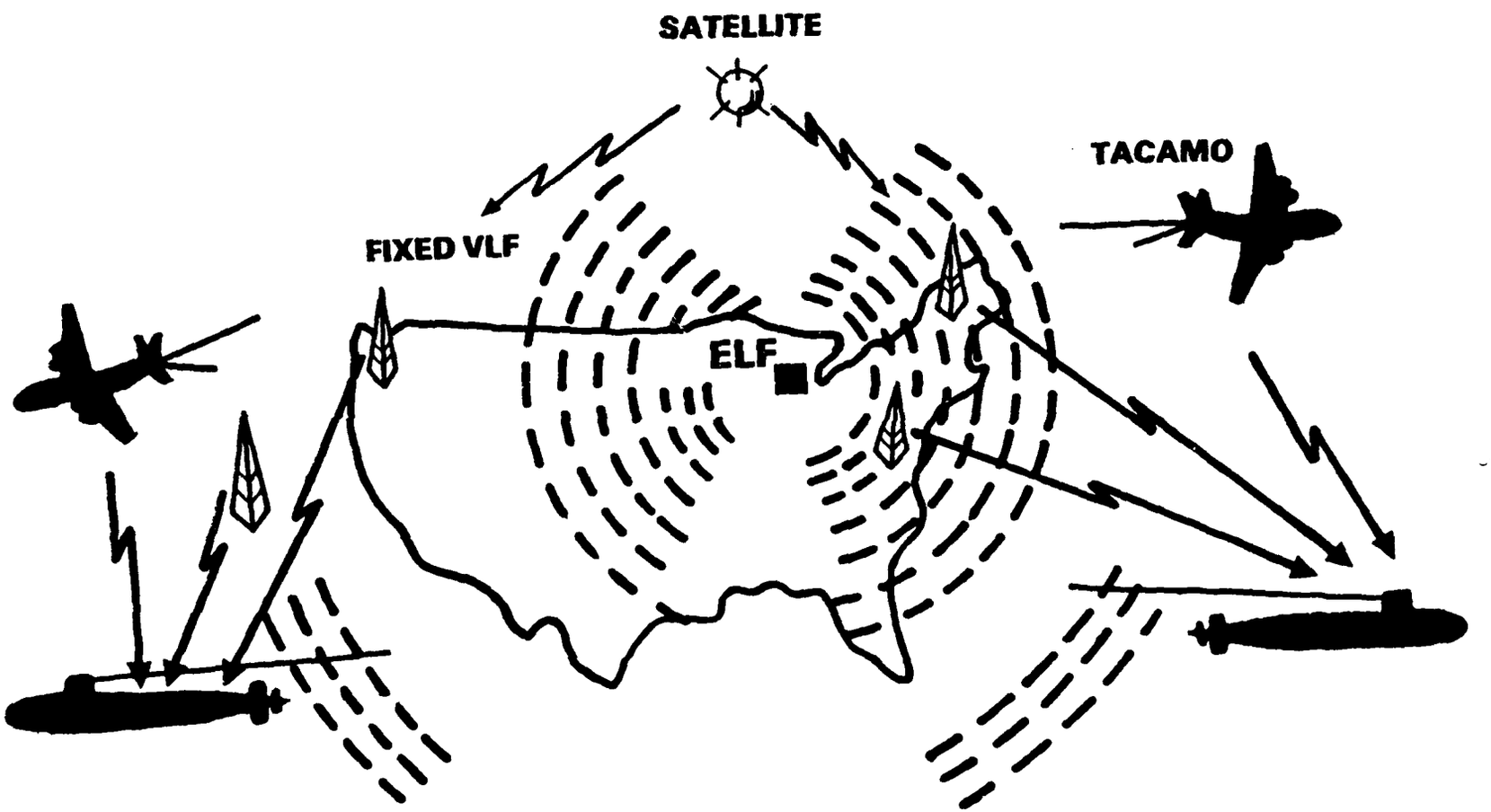


FIGURE 2 - COMMUNICATIONS TRANSMISSION ASSETS FOR SUBMARINES

will reduce the risk of detection by allowing submarines to remain deep for long periods of time, will enhance survivability by limiting the time required near the surface to search for and receive new instructions, and will improve strategic flexibility through command control communications from shore commanders to submarines patrolling or transiting at widely varying depths and speeds.

THE WISCONSIN TEST FACILITY UPGRADE

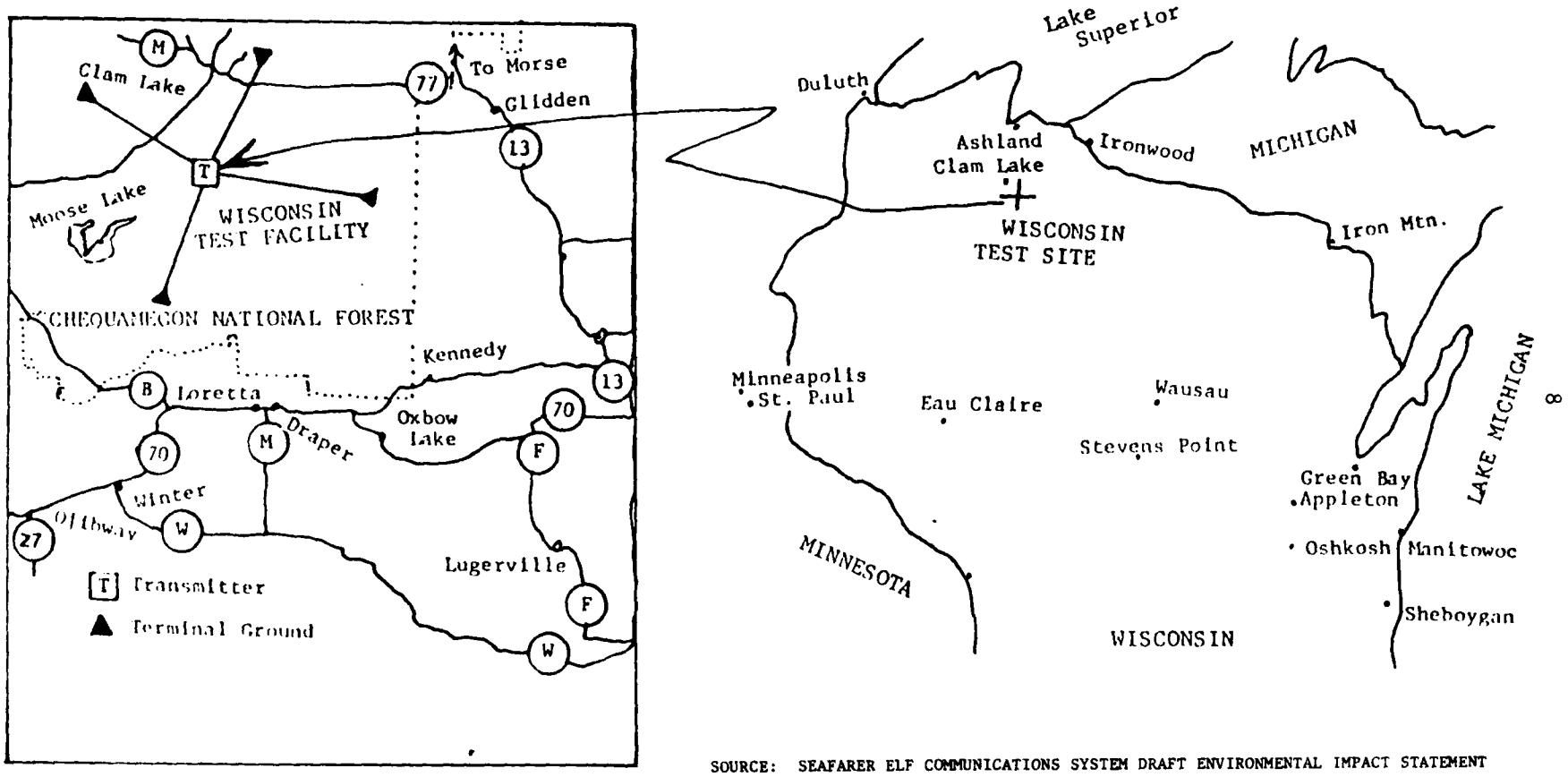
The Department of the Navy announced on July 1, 1968 that an ELF communications test facility would be constructed in northern Wisconsin*. This facility, completed and initially operated in 1969, is located entirely within the Chequamegon National Forest south of the village of Clam Lake and west of the town of Glidden, Figure 3. The transmitter building is shown in Figure 4. The antennas are overhead, installed on utility poles (Figure 5) and extend from the transmitter building for approximately seven miles in the north, south, east and west directions. Each antenna consists of two bare aluminum conductors.

The antenna routes are irregular (not straight lines) and were selected by mutual agreement between the Navy and the U.S. Forest Service. The antennas cross some roads and streams through underground conduits, and others by overhead off-sets to avoid clear views of the rights-of-way from roads. The rights-of-way are brushed by the Navy to prevent antenna damage from wind-blown trees and to minimize the likelihood of fire. No herbicides or pesticides are used, and the rights-of-way are neither patrolled nor fenced.

Four distributed ground terminals, one at each of the ends of the two antennas, provide paths for the antenna current to pentrate deep into the earth. The ground terminals are uninsulated copper conductors typically buried six feet deep. Copper rods driven as much as thirty feet into the earth are welded to the buried conductors in some places. This achieves low impedance and distributes the antenna current for electrical safety. The lengths of the four grounds vary from 8,400 feet to 10,900 feet. Like the antenna rights-of-way, vegetation is brushed and the four areas are open to public access.

The original purpose of the Wisconsin Test Facility was to perfect methods for limiting electrical interference between ELF antennas and other long conductors. A model power distribution line and a model telephone plant were built close to the test antennas for this purpose, Figure 6. Methods have been developed to prevent interference which might otherwise cause light bulbs or television receivers to flicker, or telephones

* _____; Navy to Build Experimental Communication Facility in Northern Wisconsin; Ninth Naval District Public Affairs Office Release No. 36-68; July 1968.



SOURCE: SEAFARER ELF COMMUNICATIONS SYSTEM DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR SITE SELECTION AND TEST OPERATIONS, SUPPLEMENT FOR SYNCHRONOUS EXPERIMENTAL OPERATIONS: NAVAL ELECTRONIC SYSTEMS COMMAND; SEPTEMBER 1977.

FIGURE 3 - LOCATION OF THE ELF TEST FACILITY IN WISCONSIN

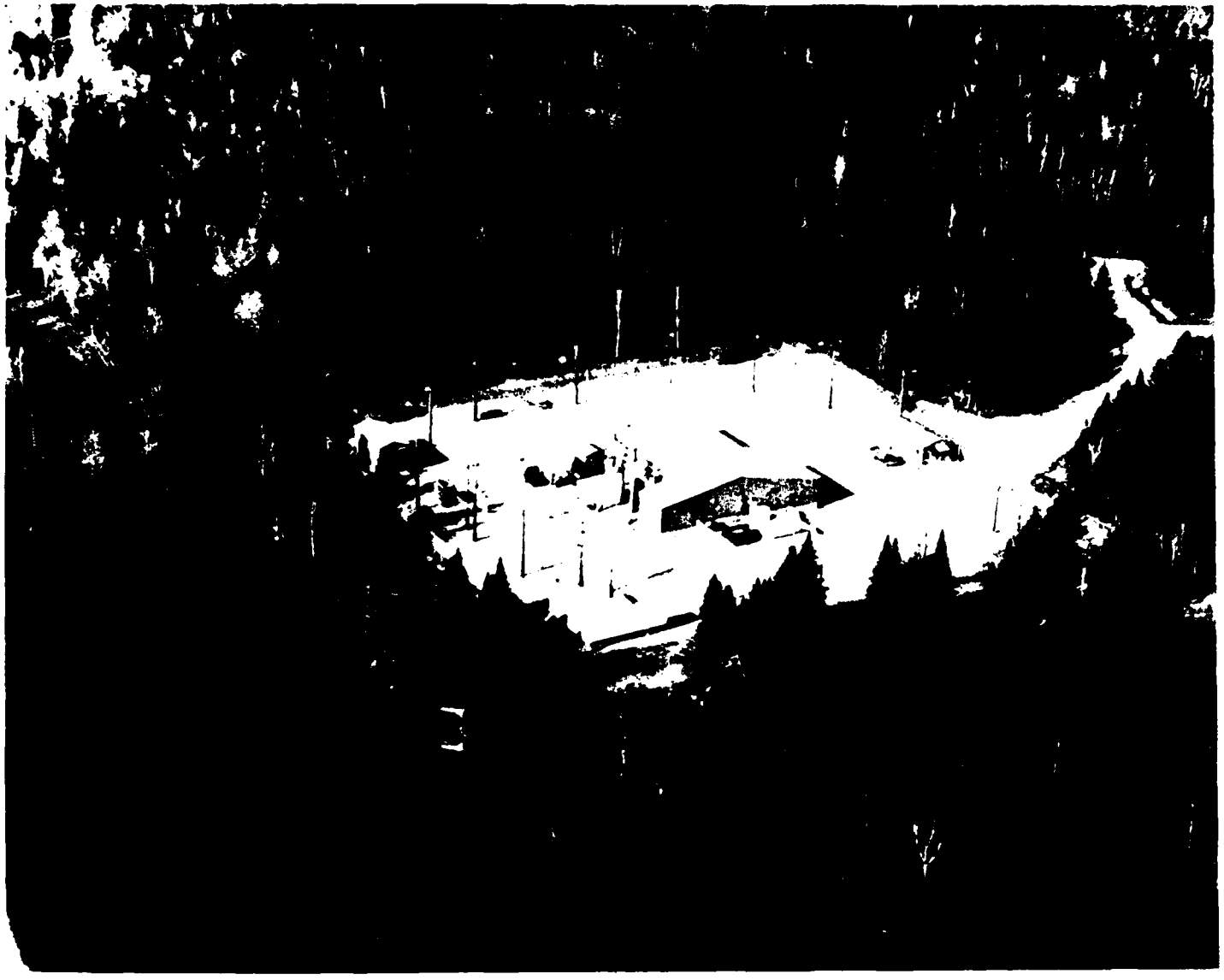
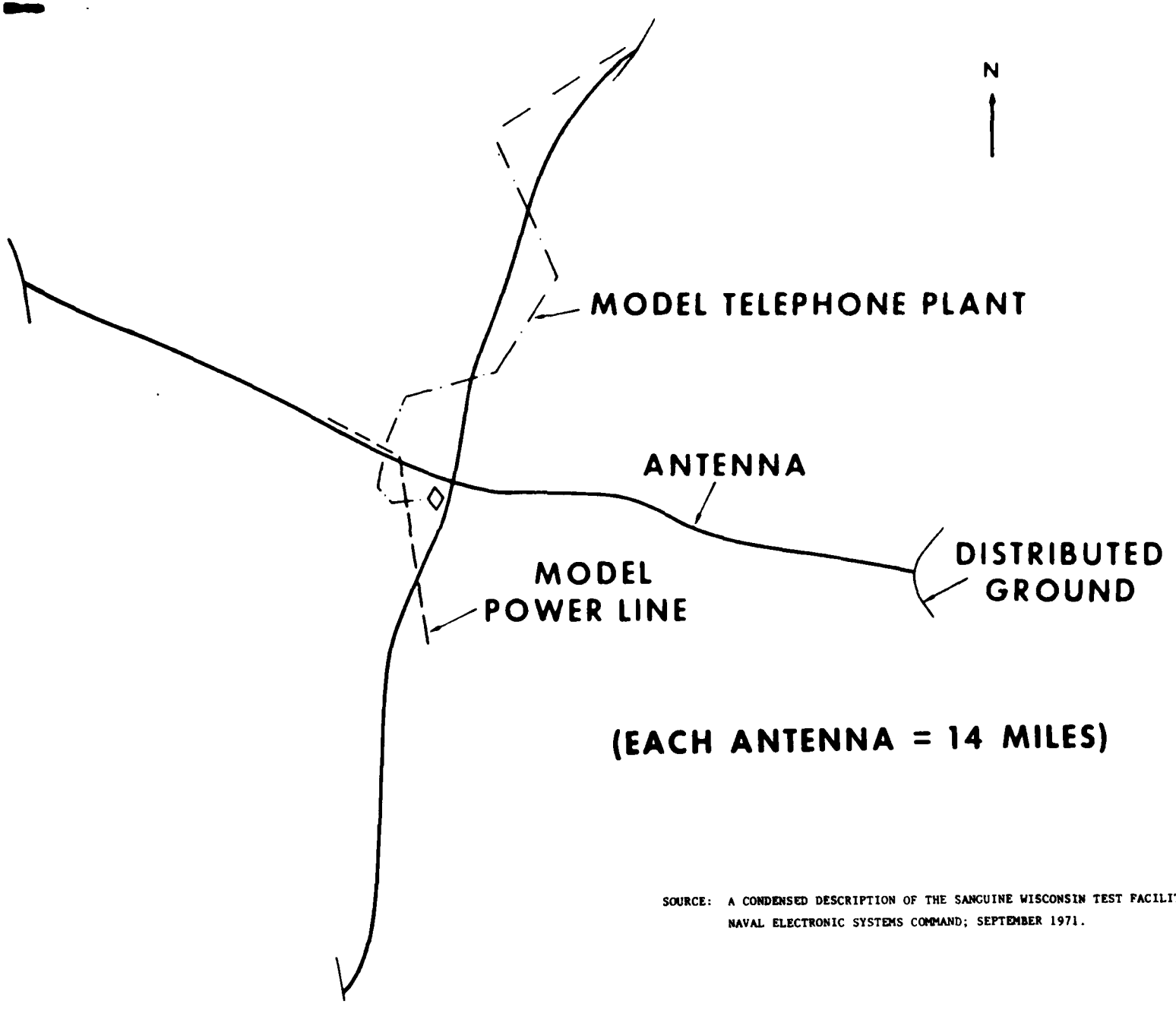


FIGURE 4 - THE ELF TRANSMITTER NEAR CLAM LAKE, WISCONSIN

FIGURE 5 - OVERHEAD ELF ANTENNA IN CHEQUAMEGON NATIONAL FOREST, WISCONSIN



SOURCE: A CONDENSED DESCRIPTION OF THE SANGUINE WISCONSIN TEST FACILITY; NAVAL ELECTRONIC SYSTEMS COMMAND; SEPTEMBER 1971.

FIGURE 6 - PLAN VIEW OF WISCONSIN TEST FACILITY ANTENNA SYSTEM AND MODEL UTILITIES

to ring without being used by subscribers. The methods also prevent unsafe ELF voltages from appearing on the wires of these systems, or on long wire fences. These mitigation methods have been applied successfully to commercial public utilities near the Facility to prevent interference effects on consumer services. Interference mitigation costs are paid by the Navy.

The Wisconsin ELF Facility has been used for ecological studies to complement laboratory research on ELF electromagnetic biological effects. The Facility also is used for ELF signal propagation tests, transmitting signals to ELF test receivers at distant land bases and on submarines.

THE ELF TRANSMITTER

The experimental transmitting equipment at the Wisconsin Test Facility is more than thirteen years old. New equipment will be designed, built and installed to improve the efficiency and reliability of the system, and reduce maintenance. The new equipment will make it easier and more economical to obtain spare and replacement parts. New buildings which may be required for the equipment will be constructed on the present site.

THE ELF ANTENNAS

The two-conductor overhead antenna system will not be changed. Antenna currents of 300 amperes will be used, as is presently the case. Periodic brushing of the antenna rights-of-way will continue.

THE ELF GROUND TERMINALS

Periodic maintenance of the four ELF ground terminals will continue to ensure their operational integrity (electrical continuity and low resistance) and safety.

Research and development for achieving low resistance terminal grounds may be performed in Wisconsin. It would be useful to determine whether there are cost-effective alternatives to long, buried horizontal ground terminals like those installed in Wisconsin thirteen years ago because four new ground terminals will be required in Michigan. Long horizontal grounds provide necessary low impedance. Deep vertical grounds may produce desirably low

voltage gradients on the earth's surface. The former require relatively long rights-of-way, and the latter might reduce the need for rights-of-way if low impedance requirements can be satisfied at reasonable installation cost. Conductivity of the earth is an important factor in either case, and its influence can best be examined through experimentation.

NAVY-U.S. FOREST SERVICE COORDINATION

The Navy has coordinated its activities at the Wisconsin Test Facility since 1969 with U.S. Forest Service representatives responsible for managing the Chequamegon National Forest. This coordination has made it possible for the Forest Service to manage the Forest and others to use its resources without restrictions due to the presence of the test facility. This coordination will continue throughout the life of the system.

INTERFERENCE MITIGATION

The public utility systems in the Clam Lake area, like those elsewhere, expand or otherwise change in response to new customer needs and opportunities to provide new types of services; desires by operating companies to improve system reliability, reduce maintenance, repair, and operating costs; and the like. Interference mitigation necessary to maintain electromagnetic compatibility between ELF systems and utility systems must also be responsive to these requirements.

The Navy will continue to provide the operating utilities in the area with no-cost consultation services to ensure that ELF interference mitigation requirements are included in new plant designs and planned modifications of existing plant. Yearly reimbursements to operating utilities will continue for professional, management and administrative costs related to ELF interference considerations. Periodic inspections of mitigated utility systems also will continue to ensure that consumers are provided with interference-free services.

ECOLOGICAL CONSIDERATIONS

The Navy provided funds from 1969 until 1977 to the U.S. Forest Service and independent investigators to investigate whether changes could be perceived

in important ecological factors due to electromagnetic energy produced at the Wisconsin Test Facility (see references listed on pages A-1 and A-2 of this report for the availability of environmental impact statements). Results of those studies did not imply that ELF energy produced ecological changes, but neither could they support conclusions that no ecological changes occurred because there is no comparable preconstruction data base. This limitation has been recognized by the Navy and numerous review committees which have examined this question.

Studies of this nature could be continued in the Clam Lake area but are not currently planned. An ecological monitoring program will be initiated prior to ELF construction in Michigan and continued thereafter. The environment in Michigan, being similar to that in Wisconsin, makes it possible to interpret the results obtained in Michigan for ecological assessments for Wisconsin. Results from Michigan will be available for this purpose.

PLANNED ACTIVITIES IN WISCONSIN

NEW EQUIPMENT AND FACILITIES

New ELF transmitting equipment will be designed and tested by the system design contractor at his engineering laboratories. The equipment will be transported to Clam Lake after testing is completed and installed at the present ELF site.

Additional tests will be conducted after the equipment is installed at Clam Lake. Tests will be made into dummy loads to ensure the equipment operates according to specifications. These tests involve measurements of Telephone Influence Factors (TIF) to assure that ELF energy is not reflected back from the transmitting equipment onto the commercial power transmission line serving the facility. Energy reflected on transmission lines can couple to telephone lines and cause interference to subscribers. these tests, commonly made at industrial facilities that use frequency converters, are not unique to the ELF system. Filters will be designed and installed if necessary to prevent this type of interference. Filters are currently used with the present equipment for this purpose.

Filters are also used between the ELF transmitter and the antennas to prevent harmonic coupling. The present filters will be used if possible, or new filters will be designed and installed. Tests will be conducted with the new equipment to ensure that Federal Communications Commission interference rules are satisfied.

ELF ANTENNA GROUND TERMINALS

Maintenance of the four present ground terminals will be continued to assure their continued safe operation. In the past this has included some land contouring to account for weather-related surface changes which occur naturally over the years. This kind of work is also sometimes required to compensate for settling or other changes in original fill over the buried cables. Voltage gradient measurements and apparent body current measurements are made periodically and after corrective actions are made. This work is coordinated with the U.S. Forest Service to prevent unwanted side effects (changes in local drainage patterns, for example). Continuation of this type of maintenance may be necessary in future years.

Although it has been unnecessary during the past twelve years, forest management practices or land use changes in the future could make it desirable to relocate portions of ground terminals. An example would be road improvements. Relocating ground terminals can be done as easily as relocating public utilities.

As noted earlier, it may be desirable to conduct ELF ground terminal research and experimentation at the present site. If initiated, this work will be coordinated with the U.S. Forest Service to prevent disturbances to other forest activities.

INTERFERENCE MITIGATION

Periodic inspection and testing by the Navy and the operating utilities will be continued throughout the Clam Lake area to ensure that the ELF system does not produce interference on power distribution lines or telephone circuits. This work can be conducted without entering customers' premises. Access to private property is necessary to inspect power system grounds only where service poles and transformers are not located alongside public roads. Customer inquiries about suspected interference or other unusual conditions will be investigated promptly.

The Navy will continue its agreements with the operating utilities to provide engineering services pertaining to interference mitigation for new plant expansions and improvements to existing plants. Interference mitigation requirements will be included in the utility planning phase so that customers are assured interference-free services are continued after changes or additions are made.

ECOLOGICAL MONITORING

As discussed earlier in this report, a comprehensive ecological data base is not available for the Clam Lake area. This limits the research and studies which can be usefully conducted in the region. Past studies have not inferred observable changes due to ELF electromagnetic fields in the biota selected for investigation, and there are no current plans to conduct additional work in the area. Investigators in Wisconsin interested in this aspect of the ELF communications program are referred to the discussion of ecological monitoring in Michigan for additional information.

SCHEDULE

The current schedule of planned activities in Wisconsin is as follows:

1982 - Preliminary site work for equipment and facilities upgrade.
- Ground terminal maintenance.
- Antenna right-of-way maintenance.
- Interference mitigation inspection, verification, testing, and engineering services as requested by operating companies.
- Continue present operations.
- Continue Navy-U.S. Forest Service coordination

1983 - Continue 1982 activities.

1984 - Install new equipment and facilities.
- Initiate new equipment testing.
- Continue other 1982 activities.

1985 - Complete upgrade testing.
- Continue system evaluation operations.
- Continue other 1982 activities.

THE ELF SYSTEM IN MICHIGAN

SYSTEM SIZE

The size of the ELF system in Michigan was determined from signal strengths needed at the most distant points of interest for U.S. submarine operations. Those areas are principally in the northern hemisphere, Figure 7. The ELF IL Product (antenna length times antenna current) needed for those signal strengths was then calculated. For the best deep-earth conductivities expected in the upper Great Lakes region (typically 3.2×10^{-4} siemen/meter at 76 Hz), the IL Product is 27×10^{6} ampere-meters, one-half of which is provided by the ELF Facility in Wisconsin (28 miles of overhead antenna operated at 300 amperes). An antenna current of about 150 amperes and an antenna length of 56 miles in Michigan would produce the remainder of the IL Product. One-half of the antenna length will be perpendicular to the other half.

A 56-mile system in Michigan, operated synchronously with the Wisconsin ELF Facility, will provide the capability needed for U.S. submarine communications well into the next century.

SYSTEM LOCATION

Low, effective, deep-earth conductivity is an important factor for ELF antenna efficiency. Land use and ownership are important in minimizing perceived effects of ELF antenna rights-of-way on land values and development, and on interference mitigation technological requirements and costs. Figures 8 and 9 show ownership and land use patterns in the area*.

Public land is convenient for locating ELF antennas. Figure 8 shows there is a large area of public land in the southern part of Marquette County and the northern part of Dickinson County. These lands comprise the Michigamme, Escanaba River and Ford River State Forests (Figure 9), which cover about 700 square miles, or nearly 450,000 acres. Rights-of-way for ELF antennas and ground terminals within the forest perimeter help avoid using privately-owned land. Flexibility in antenna routing will help in avoiding unwanted disturbances on land within the forest perimeters.

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* _____; ELF Communications SEAFARER Program Site Survey Final Report, Michigan Region Summary; GTE-Sylvania, Inc., Contract No. N00039-75-0309, Naval Electronic Systems Command; July 1976.

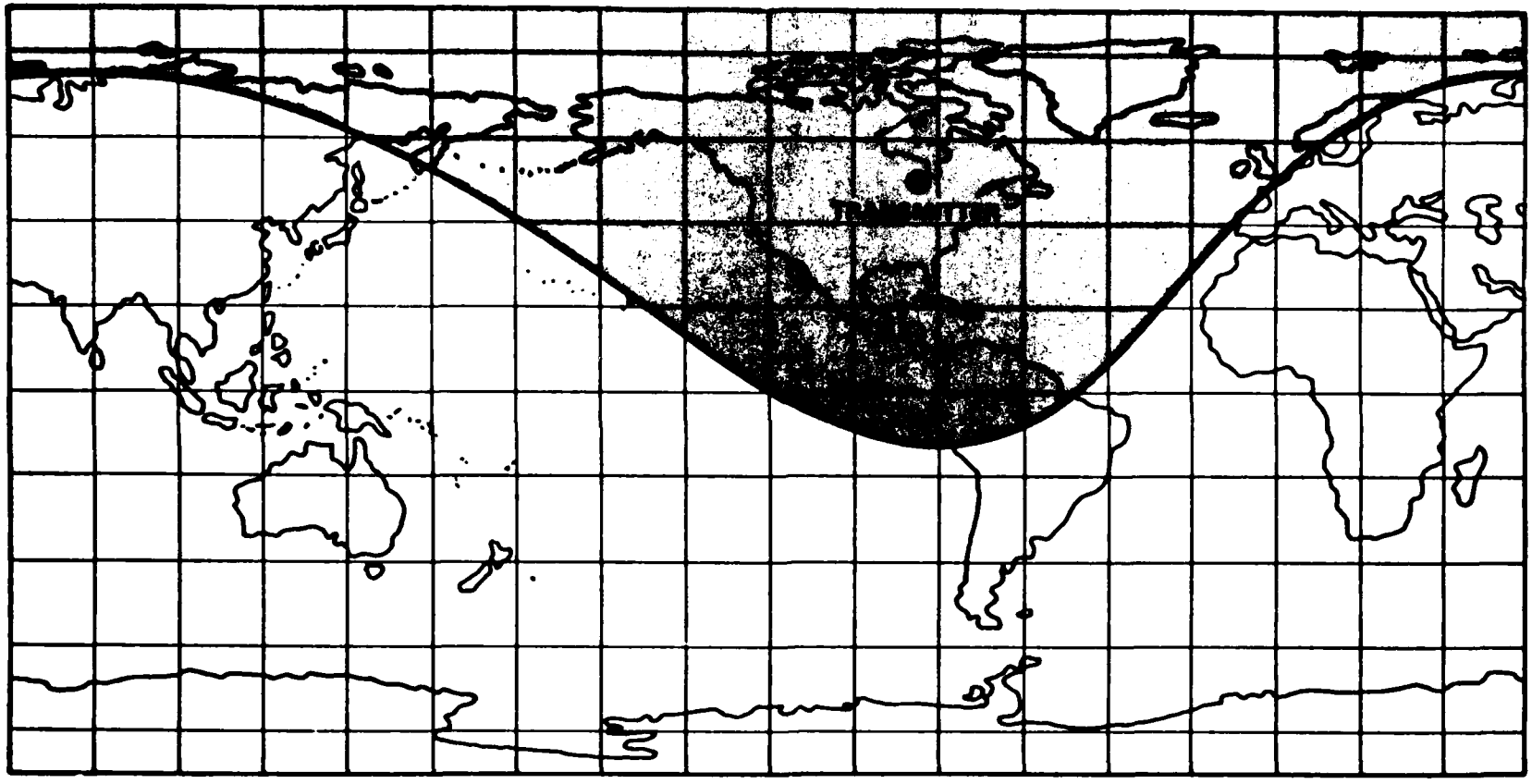
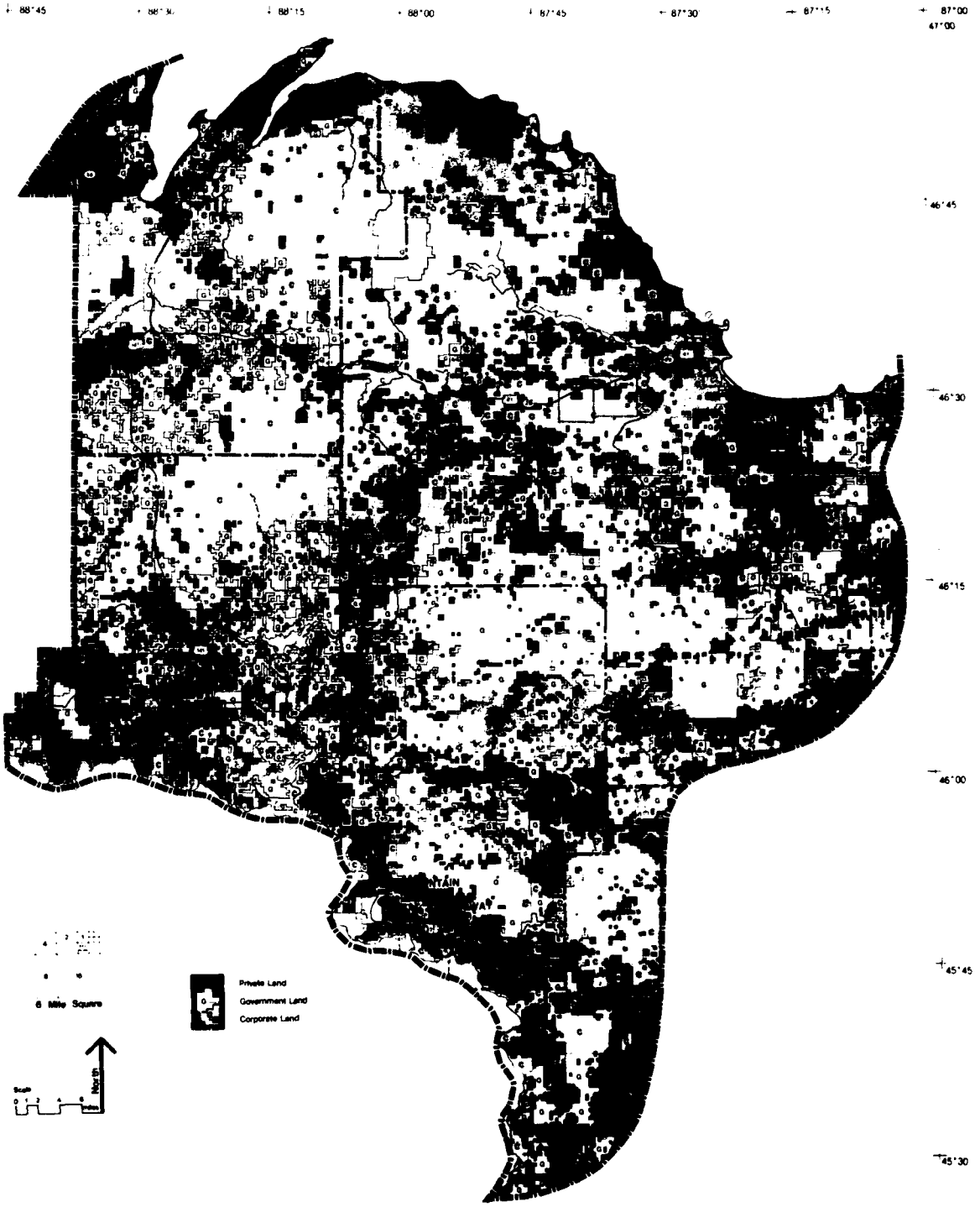
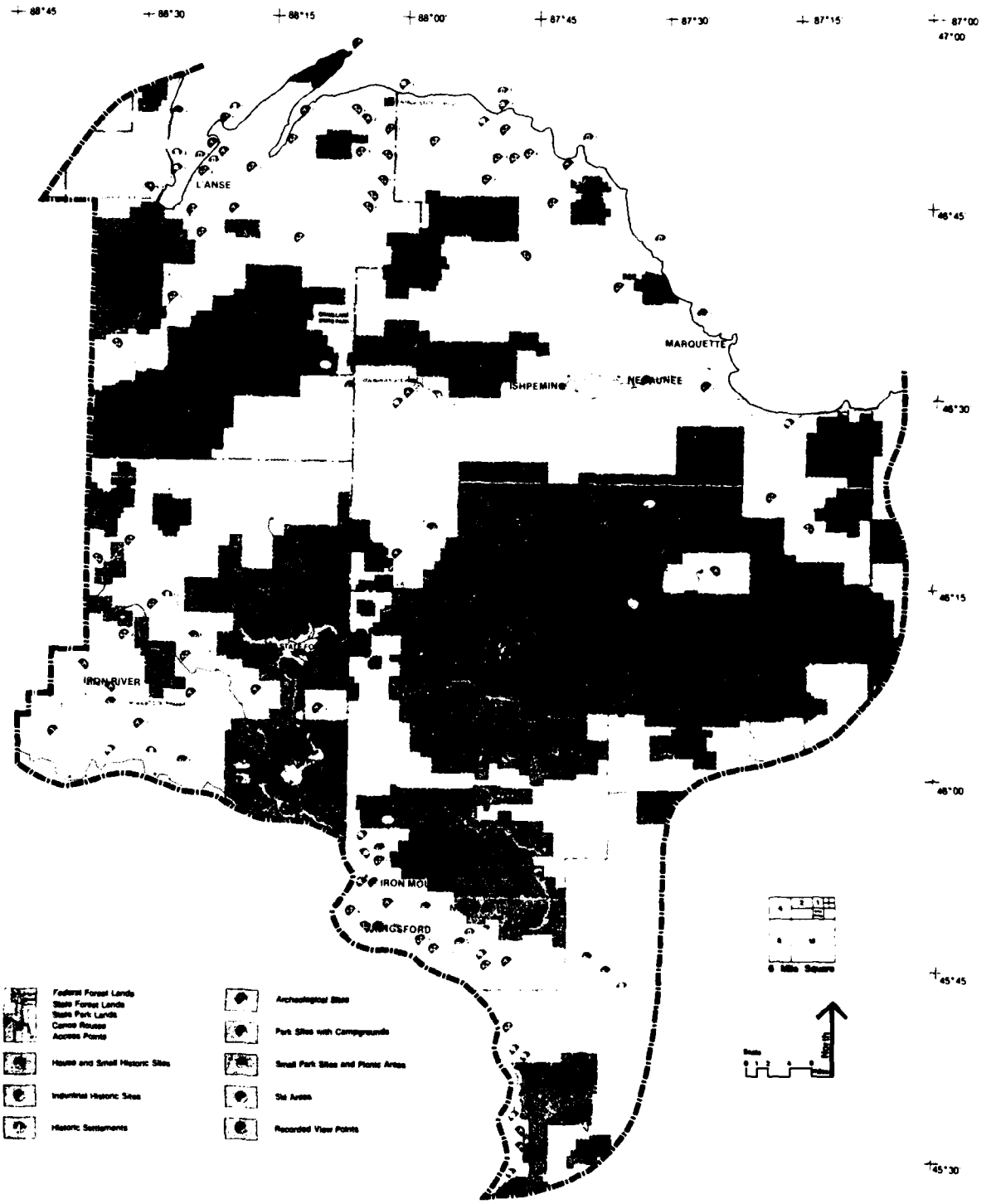


FIGURE 7 - ELF COMMUNICATIONS PROVIDED BY ANTENNA SYSTEMS IN WISCONSIN AND MICHIGAN



SOURCE: SEAFARE
BOOK 4;

FIGURE 8 - LAND OWNERSHIP IN THE MICHIGAN AREA OF INTEREST



SOURCE: SEAFARER SITE SURVEY, UPPER MICHIGAN REGION, CULTURAL AND RECREATIONAL DATA, BOOK 17; EDAW, INC.; APRIL 1976.

FIGURE 9 - LAND USE IN THE MICHIGAN AREA OF INTEREST

SYSTEM COMPONENTS

The ELF system in Michigan will include two pole-mounted orthogonal antennas, each about 28 miles long. Ground terminals will be installed at the ends of each antenna. A transmitter will be located on about two acres of land near the intersection of the antennas. Control equipment (message center, etc.) will be located on K.I. Sawyer Air Force Base.

Overhead antenna construction like that used in Wisconsin limits construction disturbances and costs. Less vegetation will be removed or damaged by construction machinery than if buried antennas were installed. Antenna damage is easily located and repaired on overhead cables.

A transmitter located near the intersection of the antennas minimizes cable lengths connecting the transmitter to the antennas. Electric power for the transmitter will be obtained from the nearest commercial source with available capacity. Emergency power generators will be installed and used to continue ELF transmissions if commercial power should be interrupted.

The control equipment for ELF coding, like that for any other Navy transmission, requires security. Locating the equipment on K.I. Sawyer Air Force Base avoids installing security systems in the forests.

Details about antenna locations and construction are not currently specified. Antenna rights-of-way will be coordinated with cognizant state agencies. The widths of rights-of-way, antenna pole sizes and the use or absence of supporting crossarms will be specified following discussions with those agencies. Unless desired by the state, maintenance practices and use of rights-of-way similar to practices in Wisconsin will be followed in Michigan; i.e., rights-of-way will be open to public access and periodic brushing will be done by the Navy.

INTERFERENCE MITIGATION

Interference mitigation will be necessary in Michigan as it is in Wisconsin to ensure that operating utilities provide ELF interference-free services to consumers after ELF antennas are installed. Costs for designing and installing mitigation are included in ELF system costs and paid for by the Navy. As in Wisconsin, operating utilities affected by mitigation will be reimbursed for recurring costs after initial mitigation is completed.

Utility customers are not affected by mitigation planning, design or installation, and incur no additional billing for changes made to utility systems. Service improvements may result in some places after mitigation is completed. Improvements can occur where neutralizing transformers are installed in telephone circuits, for example. The transformers reduce existing 60 Hz interference on telephone circuits as well as interference from ELF antennas.

PLANNED ACTIVITIES IN MICHIGAN

The Department of the Navy will work with agencies of the State of Michigan to identify suitable locations for two ELF antennas, four ground terminals and a transmitter building. The Navy expects that Michigan experts will assist in developing environmental protection plans for system construction and operations, and in formulating and conducting an ecological monitoring program to be initiated prior to system construction and continued thereafter. Investigators in Wisconsin and government agencies in that state also may have an interest in participating in the ecological monitoring program.

SYSTEM DESIGN, INSTALLATION AND TESTING

As is the case for Wisconsin, the ELF transmitting equipment will be designed and tested by the system design contractor at his engineering laboratories. The equipment will be shipped to Michigan after testing is completed and installed at the selected transmitter site. The system control equipment will be shipped to K.I. Sawyer Air Force Base and installed there. Additional testing much like that described for Wisconsin will then be conducted on site.

Concurrent with this effort by the system design contractor, the Navy will conduct other activities in the State of Michigan and elsewhere. These activities are described below.

ANTENNA AND GROUND TERMINAL LOCATIONS

Deep-earth conductivity information is necessary to locate antennas and ground terminals for best performance. The Navy plans conductivity measurements within the forest perimeter. The deep-earth conductivity data will be used to identify the best conductivities so that the highest antenna efficiency can be obtained. The most suitable near-surface conductivity data will help identify precise locations for ground terminals at the ends of the antennas. Near-surface conductivity data are also important for identifying interference mitigation requirements.

Conductivity measurements in the state forests will not disturb other activities. Teams of several persons each will measure conductivity in one place and then move to another, much like land survey teams work. Activities

will be coordinated with the Michigan Department of Natural Resources and other appropriate state agencies.

Arrangements will be made to obtain engineering information from public utility systems (power systems; telephone systems; railway signal, traffic control and communications systems; pipeline transmission, distribution an' monitoring systems; community antenna systems). This information will be used to plan interference mitigation and identify utility rights-of-way in the state forests. Surveys will be made to identify long wire fences and other surface or buried conductors which might require analysis for interference mitigation planning and antenna location studies. Identical information was collected in the 1960's to plan and construct the ELF facility near Clam Lake in Wisconsin.

The Navy will review forest management practices, plans and policies with the Michigan Department of Natural Resources staff and other state representatives. The information on land use, results of conductivity analyses, and data pertaining to interference mitigation will be used to identify candidate routes for the two orthogonal antennas, locations for the ELF transmitter station (about two acres are needed), and locations for the four ground terminals. Identifying rights-of-way which might be shared as routes for ELF antennas is an important part of this work. Federal agencies with cooperative agreements with the state which affect forest management would also be expected to participate in these studies. It is expected that two antenna rights-of-way, locations for ground terminals, and the ELF transmitter location will be identified in 1982.

ENVIRONMENTAL PROTECTION PLAN

The Navy will comply with applicable state and Federal laws, rules and regulations pertaining to environmental quality and environmental protection in proceeding with the construction of new ELF facilities. The requirements of these laws, rules and regulations will be identified and system construction contractors will be required to satisfy substantive criteria.

The Navy will work with cognizant state agencies to identify applicable state requirements. Those requirements and Federal laws, rules and regulations

will be incorporated into an environmental protection plan. The plan will be available in 1982 and will include criteria for the following:

- Land, Natural and Cultural Resources
- Air Quality
- Water Quality
- Electromagnetic Interference Mitigation

ECOLOGICAL MONITORING PROGRAM

An ELF ecological monitoring program will be used to obtain information for assessing whether electromagnetic fields associated with ELF antennas and ground terminals might produce biologic effects over a long time. The Navy will develop a draft ecological monitoring program in 1982. Comments and advice from state agencies and other experts will be used to modify the draft program and initiate preconstruction work. Initiating the data base phase of the program in 1982 will yield several years of preconstruction data for assessing the program in later years.

TABLE I

PLANNED ELEMENTS OF THE DRAFT ECOLOGICAL MONITORING PROGRAM

GENERAL REQUIREMENTS
STATISTICAL REQUIREMENTS
PROPOSALS FOR PROGRAM ALTERNATIVES
GENERAL DESIGN
REQUIREMENTS FOR PAIRED PLOTS
ELECTROMAGNETIC EXPOSURE LEVELS

AMBIENT MONITORING - TERRESTRIAL
- AQUATIC
- ATMOSPHERIC

PRE-CONSTRUCTION DATA BASE - AVAILABLE DATA FROM FEDERAL, STATE, COMMERCIAL AND PRIVATE SOURCES
- NEW FIELD STUDIES

ECOLOGICAL STUDIES

SOIL MICROFAUNA
EARTHWORMS
SMALL MAMMAL BIOMETRIC SURVEY
LARGE MAMMAL STUDIES
CROPS, HERBS AND GRASSES
TREES
PERIPHYTIC ALGAE
AQUATIC INSECTS
FISH STUDIES
POLLINATING INSECTS
NESTING BIRDS
MIGRATING BIRDS IN FLIGHT
YEARLY SUMMARY REVIEW OF HUMAN HEALTH EFFECTS LITERATURE

DATA INTERPRETATION - INTERPRETATION BY PRINCIPAL INVESTIGATOR
- INTERPRETATION BY STATE REPRESENTATIVES
- INTERPRETATION BY DEPARTMENT OF THE NAVY.

SCHEDULE

The current schedule of planned activities in Michigan is as follows:

1982 - Deep-earth conductivity measurements for antenna routes and near-surface conductivity measurements for ground terminal locations and interference mitigation engineering.

- Collect public utilities and long conductor data base.
- Negotiate antenna routes, ground terminal locations and transmitter location.
- Develop environmental protection plan.
- Develop ecological monitoring program and initiate pre-construction studies.

1983 - Initiate construction work.

- Complete preliminary interference mitigation engineering.
- Continue ecological monitoring program.

1984 - Complete construction work.

- Initiate equipment installation.
- Complete final interference mitigation engineering and initiate utility system conversions.
- Continue ecological monitoring program.

1985 - Complete equipment installation.

- Complete interference mitigation installations.
- Commence system evaluation and interference mitigation tests.
- Continue ecological monitoring program.

1986 - Complete system evaluation and interference mitigation tests.

- Initiate synchronous operations with Wisconsin ELF Facility.
- Continue ecological monitoring program.

CONCLUSION AND SUMMARY

The ELF Communications Program approved by the President will improve the ability of submarines to remain undetected, to receive important messages and thereby remain safe and effective as other nations improve their abilities to monitor U.S. submarine operations.

Coded ELF messages will be sent continuously to advise submarines to maintain their current operations (speed, course and destination), to change their operations (change destination, for example), or to receive transmissions by another means. The ELF signals can be received at great depth and high speeds. A submarine may approach the surface at an opportune time and use its other antennas to receive instructions from another source, such as a TACAMO aircraft. Thus, the ELF system will reduce the risk of detection by allowing submarines to remain deep for long periods of time, will enhance survivability by limiting the time required near the surface to search for and receive new instructions, and will improve strategic flexibility through command control communications from shore commanders to submarines patrolling or transiting at widely varying depths and speeds.

The experimental transmitting equipment at the Wisconsin test facility is more than thirteen years old. New equipment will be designed, built and installed to improve the efficiency and reliability of the system, and reduce maintenance. New buildings which may be required for the new equipment will be constructed on the present site.

The two-conductor overhead antenna system will not be changed. Antenna currents of 300 amperes will be used as is presently the case. Periodic maintenance of the four ELF ground terminals will continue to ensure their operational integrity (electrical continuity and low resistance) and safety. Some additional research and development for low resistance terminal ground designs may be performed in Wisconsin. It would be useful to determine whether there are cost-effective alternatives to long, buried, horizontal ground terminals like those installed in Wisconsin thirteen years ago.

The Navy will continue to provide the operating utilities in the Clam Lake area with no-cost consultation services to ensure that ELF interference mitigation requirements are included in new utility plant designs and planned modifications of utility plants. Yearly reimbursements to operating utilities will continue for costs related to ELF interference. Periodic inspections

of mitigated utility systems will also continue to ensure that customers are provided with interference-free services.

Ecological field studies in the Clam Lake area are not planned because of the absence of a comparable preconstruction data base. An ecological monitoring program will be initiated prior to ELF construction in Michigan and continued thereafter. The environment in Michigan, being similar to that in Wisconsin, makes it possible to interpret the results obtained in Michigan for ecological assessments for Wisconsin. Results from Michigan will be available for this purpose.

The Navy has coordinated its activities at the Wisconsin test facility since 1969 with U.S. Forest Service representatives for the Chequamegon National Forest. This coordination has made it possible to manage and use the Forest without restrictions due to the presence of the test facility, and will be continued. The ELF Communications Program work commencing in 1982, with a planned completion in 1985, will not affect local communities, users of forest resources, or residents and visitors who use other recreational resources in the Clam Lake area.

The size of the ELF system in Michigan was determined from signal strengths needed at the most distant points of interest for U.S. submarine operations. Those areas are principally in the northern hemisphere (see Figure 7). The ELF IL Product (antenna length times antenna current) needed for those signal strengths was then calculated. One-half of the IL Product is provided by the ELF Facility in Wisconsin (28 miles of overhead antenna operated at 300 amperes). An antenna current of about 150 amperes and an antenna length of 56 miles in Michigan will produce the remainder.

Public land is convenient for locating ELF antennas. There is a large area of public land in the southern part of Marquette County and the northern part of Dickinson County comprising the Michigamme, Escanaba River and Ford River State Forests, which cover about 700 square miles, or nearly 450,000 acres. Antenna rights-of-way within the forest perimeter help avoid using privately-owned land. Flexibility in antenna routing will help in avoiding unwanted disturbances on land within the forest perimeters.

The ELF system in Michigan will include two pole-mounted antennas, each about 28 miles long. Ground terminals will be installed at the ends of each antenna. A transmitter will be located on about two acres of land near the

antenna. A transmitter will be located on about two acres of land near the intersection of the antennas. Control equipment like that used for other Navy communications will be located on K.I. Sawyer Air Force Base to avoid installing security systems in the forests. Electric power for the transmitter will be obtained from the nearest commercial source with available capacity. Emergency power generators will be installed and used to continue ELF transmissions if commercial power should be interrupted.

Details about antenna locations and construction are not currently specified. Antenna rights-of-way will be coordinated with cognizant state agencies. The widths of rights-of-way, antenna pole sizes and the use or absence of supporting crossarms will be specified following discussions with those agencies. Unless otherwise desired by state representatives, public access will be permitted and periodic brushing will be done by the Navy.

Interference mitigation will be necessary in Michigan as it is in Wisconsin to ensure that operating utilities provide interference-free services to consumers after ELF antennas are installed. Costs related to design and mitigation installation are included in ELF system costs and are paid by the Navy. As in Wisconsin, operating utilities affected by interference mitigation will be reimbursed for recurring costs after initial mitigation is completed. Customers are not affected by mitigation planning, design or installation, and there is no customer billing for changes made to utility systems.

As is the case for Wisconsin, the ELF transmitting equipment will be designed and tested by the system design contractor and then shipped to Michigan and installed at the transmitter site. The system control equipment will be shipped to K.I. Sawyer Air Force Base and installed there. Additional testing will then be conducted on site.

The Navy plans conductivity measurements within the forest perimeter to identify the best conductivities to obtain the highest possible antenna efficiency. The most suitable near-surface conductivity data will help identify precise locations for ground terminals. Conductivity measurements will be coordinated with the Michigan Department of Natural Resources and other appropriate agencies so that other forest activities are not disturbed.

Arrangements will be made to obtain engineering information from public utility systems to plan interference mitigation and identify utility rights-

of-way in state forests. Identical information was collected in Wisconsin in the 1960's to plan and construct the ELF facility near Clam Lake.

The Navy will review forest management practices, plans and policies with the Michigan Department of Natural Resources staff and other state representatives. Information on land use, results of conductivity analyses, and data pertaining to interference mitigation will be used to identify candidate routes for the antennas, a location for the ELF transmitter station (about two acres are needed), and locations for the four ground terminals. Identifying rights-of-way which might be shared for routing ELF antennas is an important part of this work. Federal agencies with cooperative agreements with the state which affect forest management would also participate in these reviews.

The Navy will comply with applicable state and Federal laws, rules, and regulations pertaining to environmental protection in proceeding with the construction of new ELF facilities. System construction contractors will be required to satisfy substantive criteria. The Navy will work with cognizant state agencies to identify applicable state requirements. Those requirements and Federal laws, rules and regulations will be incorporated into an environmental protection plan.

An ELF ecological monitoring program will be conducted to assess whether electromagnetic fields associated with ELF antennas and ground terminals might produce biologic effects over a long period of time. The Navy will develop a draft ecological monitoring program in 1982. Comments and advice from state agencies and other experts will be used to modify the draft program. Initiating the data base phase of the program in 1982 would yield several years of pre-construction data for evaluating the program in later years.

REFERENCES

The U.S. Environmental Protection Agency has arranged for the sale of environmental impact statements with the Environmental Law Institute after initial supplies of reports have been depleted by issuing Federal agencies. The following statements prepared for the ELF Communications Program may be ordered at a cost of ten cents per page from:

Environmental Law Institute
1346 Connecticut Avenue, N.W.; Suite 600
Washington, D.C. 20036

1. _____; Project SANGUINE Draft Environmental Impact Statement; Naval Electronic Systems Command; March 1971; 54 pp.

2. _____; SANGUINE System Final Environmental Impact Statement for Research, Development, Test and Evaluation; Naval Electronic Systems Command; April 1972.
Volume 1 - 359 pp.
Volume 2 - Technical Annexes; 691 pp.

3. _____; Supplement to the SANGUINE System Final Environmental Impact Statement for Research, Development, Test and Evaluation; Naval Electronic Systems Command; February 1975; 285 pp.

4. _____; SEAFARER ELF Communications System Draft Environmental Impact Statement for Site Selection and Test Operations; Naval Electronic Systems Command; February 1977.

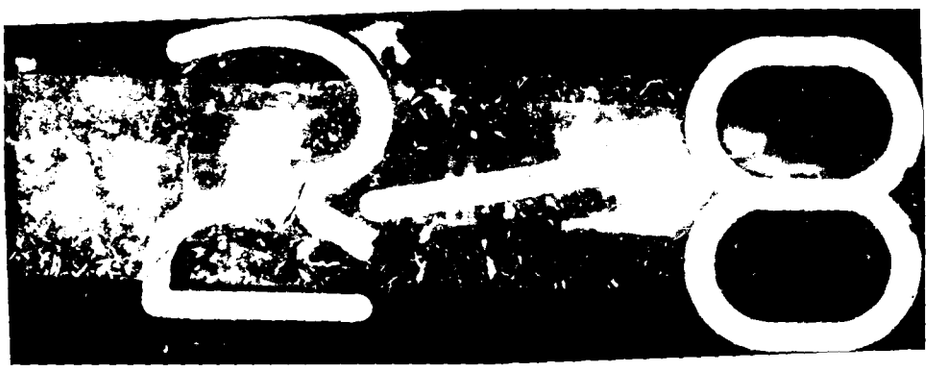
Vol. 1 - Summary Statement; 125 pp.
Vol. 2 - Environmental Statement; 386 pp.
Vol. 3 - Nevada Environmental Analysis; 315 pp.
Vol. 4 - New Mexico Environmental Analysis; 340 pp.
Vol. 5 - Michigan Environmental Analysis; 373 pp.
App. A - Site-Independent Information; 146 pp.
App. B - Nevada Information; 124 pp.
App. C - New Mexico Information; 155 pp.
App. D - Michigan Information; 157 pp.
App. E - Biological and Ecological Information; 197 pp.
App. F - Public Interest; 343 pp.
App. G - Coordination; 366 pp.
ALL VOLUMES TOTAL - 3027 pp.

5. _____; Biologic Effects of Electric and Magnetic Fields Associated with Proposed Project SEAFARER; Committee on Biosphere Effects of Extremely Low Frequency Radiation, Assembly of Life Sciences, National Research Council, National Academy of Sciences; 1977; 452 pp.

6. _____; SEAFARER ELF Communications Systems Draft Environmental Impact Statement for Site Selection and Test Operations - Supplement for Synchronous Experimental Operations; Naval Electronic Systems Command; September 1977; 21 pp.

7. _____; SEAFARER ELF Communications System Final Environmental Impact Statement for Site Selection and Test Operations; Naval Electronic Systems Command; December 1977.

Vol. 1 - Summary Statement; 115 pp.
Vol. 2 - Environmental Impacts in Nevada; 300 pp.
Vol. 3 - Environmental Impacts in New Mexico; 251 pp.
Vol. 4 - Environmental Impacts in Michigan; 610 pp.
Vol. 5 - Public Interest; 201 pp.
ALL VOLUMES TOTAL - 1477 pp.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